RF TECHNICAL NOTE

REPLACEMENT OF THE KALMUS DRIVER AMPLIFIER AT RF1-RF5

The Kalmus driver amplifiers used at RF1-RF5 are self-contained 50dB gain, 200-400MHz rf power amplifiers used for generating sufficient rf power to drive the input cavity of the klystrons used at each rf station. These amplifiers are rated at 200 watts CW rf output at RF1-RF4, and 100 watts CW rf output at RF5.

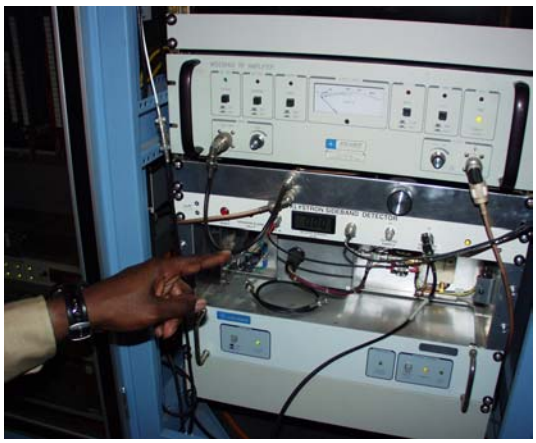
When these amplifiers fail or malfunction, they are normally replaced with identical spare units in order to minimize down time. The defective amplifier is then repaired on the bench, and either placed back in service or stored as a useable spare.

For the following reasons, special attention must be paid to the replacement of these amplifiers:

A). Because the Kalmus amplifiers at RF1-RF5 are supplied 120v ac power from an ACIS-controlled relay inside the RF/ACIS Interface Chassis, *an RF ACIS Validation must be performed at the affected rf station whenever these amplifiers are removed from the rack or replaced with a spare amplifier.* This validation is necessary to demonstrate that the ACIS system can control the 120v ac power to the amplifier after the work was performed.

B). Because none the Kalmus amplifiers have been phase-matched, the replacement of any Kalmus amplifier at RF1-RF5 will most likely result in a change in dc operating point for the klystron power-phase and cavity-sum phase loops. *Unless this change in operating point is properly compensated for, one or both of the rf phase loops at the affected rf station may lose dynamic range, be difficult to close, or be rendered totally ineffective.*

C). There are two physically different versions of the 200-watt amplifiers used in the Storage Ring rf systems (RF1-RF4), with spares for each version. These two versions occupy different amounts of vertical rack space, and are therefore not interchangeable without making major modifications to the rack installation. Note this difference in the photographs shown below:



Short-version 200-watt amp

Tall-version 200-watt amp

Steps for Removal and Replacement of a Kalmus Amplifier at RF1-RF5:

NOTE: An approved work request must exist prior to the start of any work involving a Kalmus amplifier at RF1-RF5. *The work request must indicate that the work will involve disconnecting the 120 VAC power input to the Kalmus amplifier, which involves the ACIS system.*

Note: The Radiation Safety "Critical Component" involved with this work is the 120vac line cord and connector feeding power to the Kalmus amplifier. *The Kalmus amplifier itself is not considered a critical component.*

AMPLIFIER REMOVAL

1. Turn the Kalmus amplifier off.

2. Turn the Kalmus amplifier GPIB Interface Chassis off (see Figure 1).

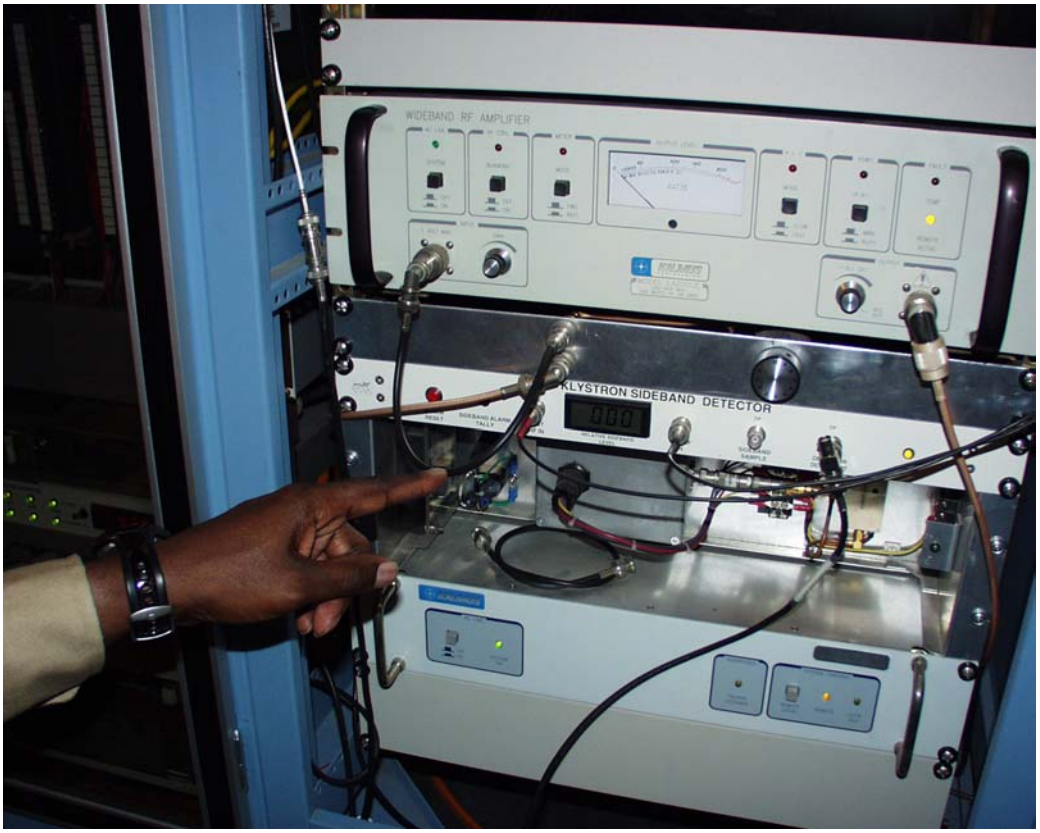


Figure 1 – Kalmus amplifier, GPIB Interface (near bottom of rack), and phasing cable connected to the amplifier rf input jack.

3. Remove the phasing cable from the amplifier rf input connector (see Figure 1).

   NOTE: All adaptors that are used to connect the phasing cable to the amplifier input jack *MUST REMAIN WITH THE CABLE* in order to preserve the calibrated phase length in the rf drive system.

4. Remove the rf output cable from the amplifier (see Figure 2).

   NOTE: All adaptors that are used to connect the rf output Cable to the amplifier input jack *MUST REMAIN WITH THE CABLE* in order to preserve the calibrated phase length in the rf drive system.

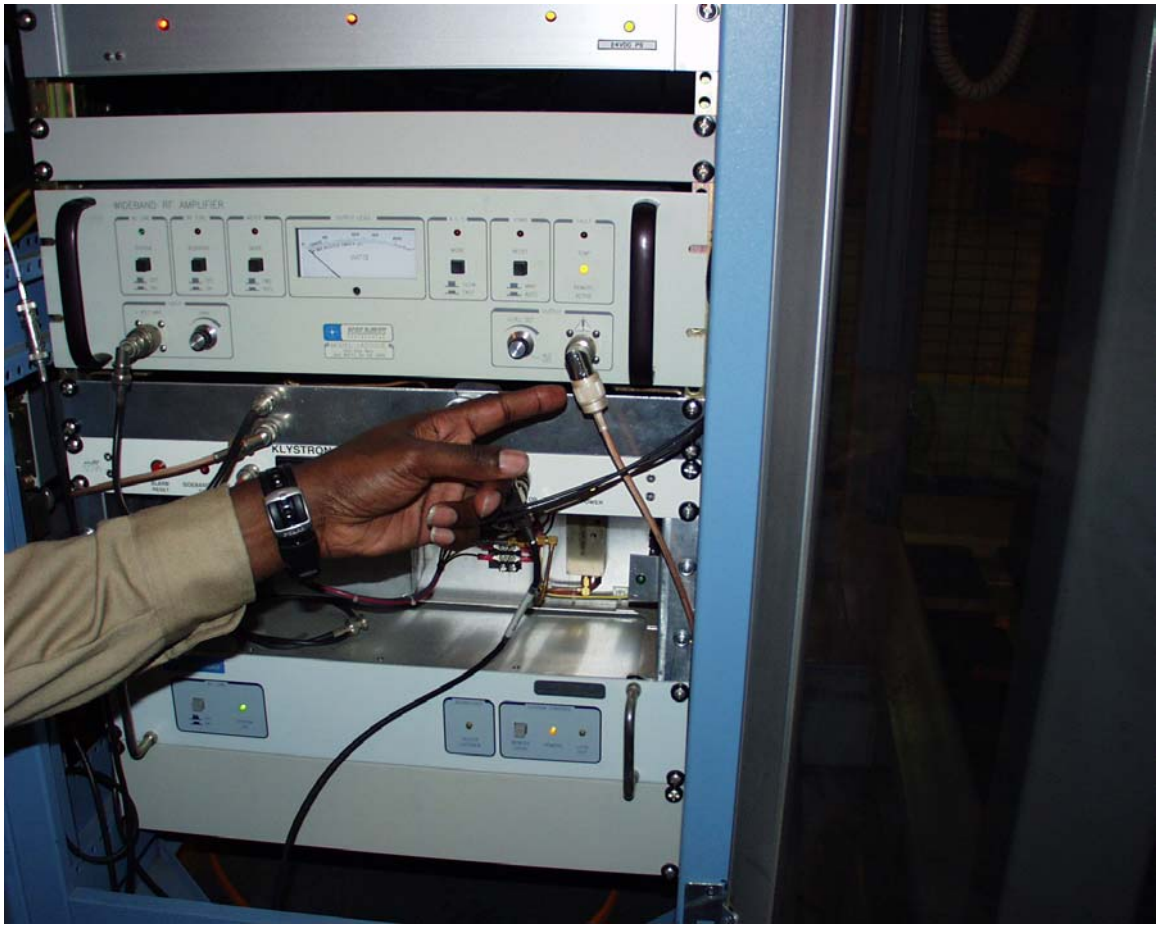


Figure 2 – RF output cable.

5. Remove the GPIB communications cable from the rear of the amplifier (see Figure 3).

Figure 3 – GPIB communications cable connected to the rear of the Kalmus amplifier.

6. Disconnect the AC line cord at the ACIS connector (see Figure 4).

NOTE: Notice the ACIS stickers affixed to the Kalmus amplifier AC Line cord. *This line cord is part of the ACIS system, and must not be tampered with without prior notice to and approval from ACIS and APS Operations.*

This step in the Kalmus amplifier removal process requires a subsequent RF ACIS Validation after the amplifier is re-installed or replaced by a spare amplifier.

Figure 4 – Kalmus ac line cord labeled as part of the ACIS system.

NOTE: The Kalmus amplifiers in service at RF1-RF5, including spares, have all been fitted with a hard-wired 120v ac line cord that utilizes a special 3-pin connector that mates with the ACIS power cord that delivers ac power to the amplifier. This modification prevents connection of the amplifier to a non-ACIS-switched 120v ac power source.

7. Remove the green chassis ground lead (see Figure 5).

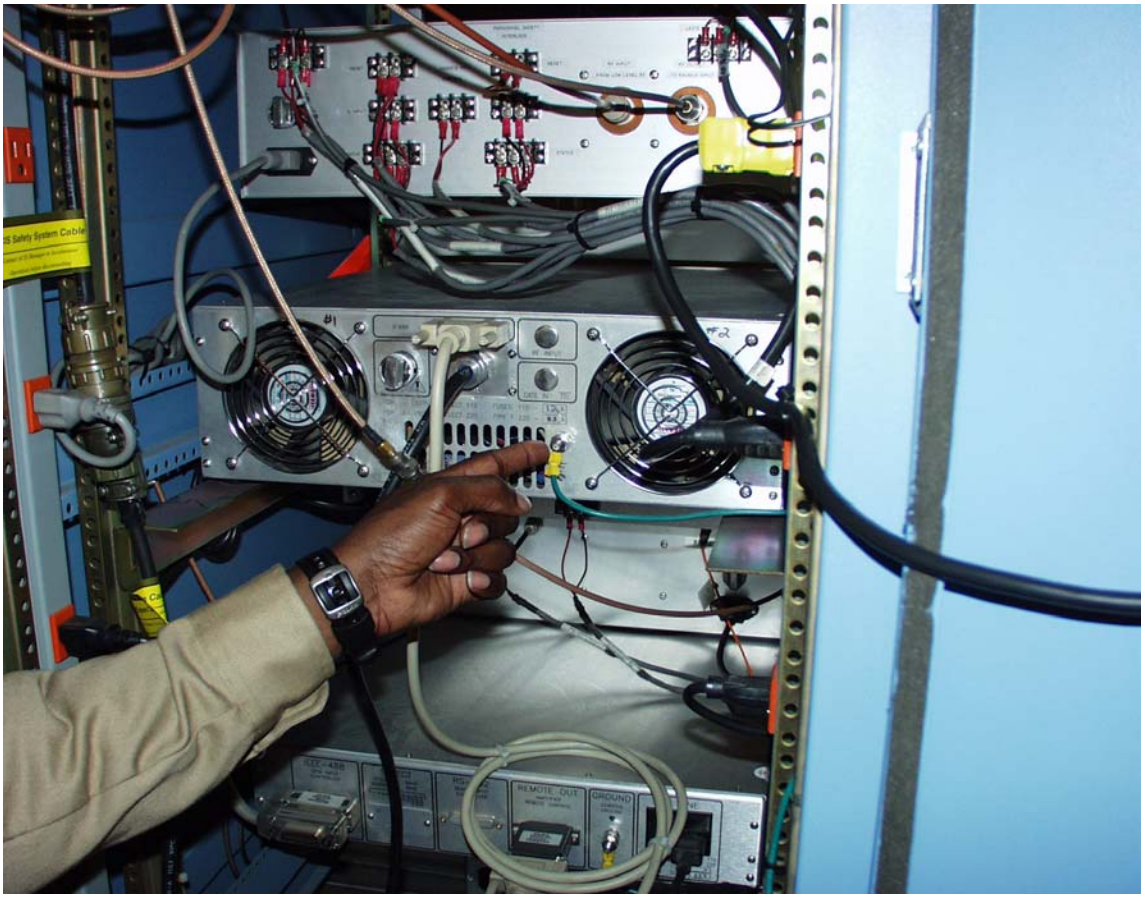


Figure 5 – Chassis ground lead.

8. Slide the amplifier chassis out of the rack from the front.

AMPLIFIER REPLACEMENT

9. Slide the replacement amplifier into the rack from the front.

10. Reconnect the green chassis ground lead (see Figure 5).

11. Connect the amplifier 120v ac line cord to the ACIS connector (see Figure 4).

12. Connect the amplifier GPIB connector (see Figure 3).

13. Connect the amplifier output cable to the amplifier (see Figure 2).

14. Connect the phasing cable to the amplifier rf input connector (see Figure 1).

15. Turn on the Kalmus GPIB interface chassis.

16. Turn on the Kalmus amplifier.

17. Perform an ACIS Validation of the rf system.

18. Turn on the rf system to a power level of approximately 25kW/cavity (at RF1-RF4), and approximately 50kW/cavity at RF5. *Reset the collector interlock at RF1-RF4.*

19. Observe the power-phase and cavity-sum phase loop feedback card output voltages to determine the loop operating points. These signals can be monitored on the klystron Xycom display at RF1-RF5 (see Figure 6), and on the analog oscilloscope display at RF1-RF4 (see Figure 7).

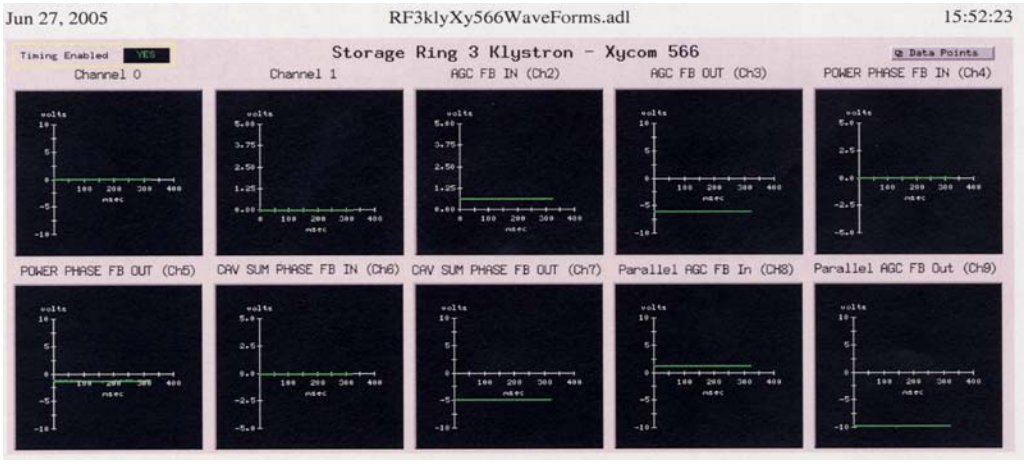


Figure 6 – EPICS Xycom display of phase loop feedback card output voltages: power-phase loop on Ch 5, cavity-sum on Ch 7.

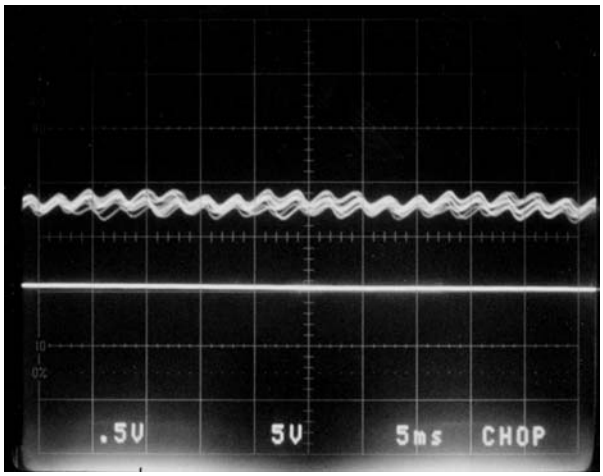


Figure 7 – Analog scope display of phase loop feedback card output voltages: Upper trace is power-phase loop signal at 0.5v/div; lower trace is cavity-sum loop signal at 5.0v/div.

20. Referring to the EPICS klystron control screen See Figure 8), adjust both phase loop offset phase shifters to set the feedback card output voltages for both loops to the standard setting of ≈ -1.50 volts for the power-phase loop, and ≈ -5.0 volts for the cavity-sum loop.

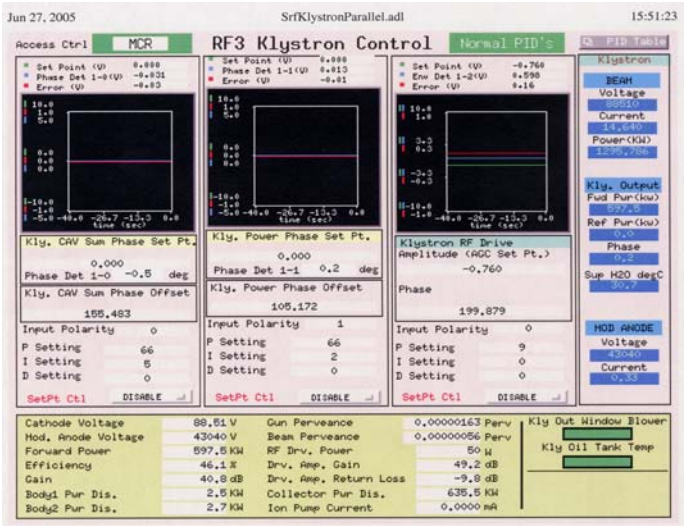


Figure 8 – Klystron control screen with phase loop offset phase shifter adjustments.

NOTE: It may not be possible to adjust the phase loop operating points to their correct values by simply adjusting the phase loop offset phase shifters. Because none of the Kalmus amplifiers are phase-matched, replacement of an amplifier may require bulk cable delay changes and possibly changes in phase loop feedback card input polarity in order to allow the power-phase and cavity-sum phase loops to reliably lock at a useful operating point.

Bulk cable-delay adjustments are made by replacing the black phasing cable that is connected between the input drive attenuator panel and the input jack of the Kalmus amplifier (see Figure 1). There are spare cables pre-made in 90º, 180º, and 270º lengths at 351.93MHz stored in the LLRF spares cabinet for this purpose. *You may need to replace the existing phasing cable with a cable of a different length in order to get the phase loops to lock and then re-lock on their own from an rf turn-on condition without problems.*

The correct bulk cable delay is selected when the phase loops operate correctly and reliably, with their respective offset phase shifters adjusted somewhere in the middle of their range.

21. Turn the rf drive off and on several times to insure that both phase loops will lock on their own without any operator intervention.

22. For the storage ring rf stations (RF1-RF4), close the Storage Ring Gap Voltage AGC Loop, and adjust the power level to ≈ 40kW/cavity. Verify that the power-phase and cavity-sum phase loops are at their correct operating points.

23. Return the rf station to normal service.